

Solutions Network Formulation Report

The Potential Contributions of the Global Precipitation Measurement Mission to Phosphorus Reduction Efforts in the Florida Everglades

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1. Candidate Solution Constituents

- a. Title: The Potential Contributions of the Global Precipitation Measurement Mission to Phosphorus Reduction Efforts in the Florida Everglades
- b. Authors: Daniel Anderson, Kent Hilbert, David Lewis
- c. Identified Partners: SFWMD (South Florida Water Management District), National Park Service, Environmental Protection Agency
- d. Specific DST/DSS: CERP (Comprehensive Everglades Restoration Plan)
- e. Alignment with National Application: Water Management, Coastal Management, Ecological Forecasting
- f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
GPM (Global Precipitation Measurement)	GMI (GPM Microwave Imager) DPR (Dual-frequency Precipitation Radar)	Rainfall Rate, Droplet Size

- g. Benefit to Society: GPM observations could help improve the Phosphorus Reduction Planning Tool, a component of the Comprehensive Everglades Restoration Plan. This DST seeks to improve the overall health of the Everglades, which provides a natural barrier from tropical storms, provides natural flood control, improves water quality by acting as a natural filtering system, and supports a wealth of wildlife.

2. Abstract

This candidate solution suggests the use of GPM precipitation observations to enhance the CERP. Specifically, GPM measurements could augment in situ precipitation data that are used to model agricultural phosphorus discharged into the Everglades. This solution benefits society by aiding water resource managers in identifying effective phosphorus reduction scenarios and thereby returning the Everglades to a more natural state. This solution supports the Water Management, Coastal Management, and Ecological Forecasting National Applications.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

One of the world's most important marshlands is dying of thirst and of a variety of other maladies. The Florida Everglades is less than half of its original size; some 50 percent of the original area has been drained and lost to agriculture. Upstream demand for water by the sugar industry and by growing cities has slowed a much-heralded restoration program to a crawl, while runoff of agricultural nutrients and urban waste has undermined the health of the entire ecosystem. Most of the area that does remain undeveloped is part of Everglades National Park, which National Geographic recently ranked as the worst of 55 National Parks in the United States and Canada based on sustainable tourism, destination quality, and park management (Tourtellot, 2007). Clearly, the Everglades is a paradise in jeopardy.

A rash of federal and state legislation has been enacted over the past several decades to protect and restore this fragile resource; perhaps the most important are the federal CERP, the state Everglades Restoration Investment Act, and the Everglades Forever Act. The Everglades Forever Act directs the State of Florida to develop a phosphorus reduction criterion for the Everglades Protection Area. The criterion numerically interprets an existing narrative standard, which states: "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna" (FDEP, 2007).

Eutrophication of the wetlands is one of the Everglades most heavily studied problems. This eutrophic state is generally caused by agricultural phosphorus and nitrogen running off the fields of the EAA (Everglades Agricultural Area). This problem is difficult to measure because much of the runoff from agriculture pollutes the coastal zones through submarine groundwater discharge. Ground water cannot be measured until it is discharged into the estuaries, yet because of the absolute flatness of the topography in the region, ground water moves very slowly. In fact, groundwater studies estimate that the nutrients dissolved into the groundwater via the EAA take 50–5 years to reach the coast (Hoeweler, 2004). If these estimates are correct, the impacts of today's actions won't be evident for half a century or more. With this in mind, a number of DSSs have been created to help study and assess the problem and to enact mitigation processes.

b. Identified Partner(s)

The SFWMD is responsible for regional flood control, water supply and water quality protection, and ecosystem restoration. The District works very closely with the U.S. Army Corps of Engineers and USGS (U.S. Geological Survey) on flood control projects and with the Environmental Protection Agency and National Park Service on conservation efforts. As part of the overall Comprehensive Everglades Restoration Plan, the SFWMD is looking for the best ways to capture agricultural phosphorus that is discharged into Lake Okeechobee and subsequently into the Everglades. The Comprehensive Everglades Restoration Plan has several decision support components. One component is the Phosphorus Reduction Planning Tool, which is an ESRI ArcGIS®-based DSS. The Phosphorus Reduction Planning Tool uses an empirically derived phosphorus assimilation algorithm that allows water resource managers to try different phosphorus reduction scenarios by placing hypothetical projects in different sub-basins and then capturing the predicted improvement in phosphorus reduction in a report for each scenario (Hornung and Salmon, 2003). The result of the tool's output is a better general understanding of the factors influencing nutrient runoff. The SFWMD then works with partner agencies and agricultural cooperatives to implement mitigation programs. Examples of mitigation techniques include constructing artificial marshland known as a Stormwater Treatment Area to help clean the water from EAA runoff before it enters the natural wetlands, returning diverted waters back into the Everglades, convincing farmers to alter harvesting techniques

and to practice conservation tillage, and establishing procedures to treat urban runoff. Currently, each project relies on certain parameters outlined in the proposed projects, but all projects rely on in situ measurements for precipitation – some of which just note historical meteorological records. Remarkably the South Florida and Everglades area has distinct dry seasons and rainy seasons. Rainfall events, especially intense or prolonged events, will naturally influence leached nutrients, making the phosphorus studies prime candidates for timely and accurate precipitation measurements.

c. NASA Earth-science Research Results

The GPM mission builds on the success of the Tropical Rainfall Measuring Mission. GPM will provide more accurate, frequent, global, high-spatial-resolution, and microphysically detailed measurements of precipitation than its predecessor. GPM is attempting to make the most comprehensive and accurate measurements of global precipitation ever obtained. This objective will be accomplished through an advanced core satellite with a first-of-its-kind dual frequency radar and passive microwave radiometer that will provide key measurements of precipitation physics and will serve as a calibrator for an international constellation of new and previously existing satellites (referred to as satellites of opportunity).

The core satellite is scheduled to launch in 2013. Each member of the constellation will carry some type of passive microwave radiometer, will provide global and temporal sampling, and will reduce error uncertainty (NASA, 2006). As a benefit to this candidate solution, the constellation satellites will allow for a 3-hour revisit time for any point on the globe while the core satellite's sensors will allow for spatial resolutions approaching 250 km (NASA, 2007). Also, one of the stated GPM science goals serves the goals of the SFWMD: "*Flood/Fresh Water Resource Prediction—Improve flood and fresh water resource prediction through frequent sampling and complete Earth coverage of high resolution precipitation measurements, plus focused research on more innovative designs in hydro-meteorological modeling*" (NASA, 2006).

d. Proposed Configuration's Measurements and Models

The SFWMD and the USGS use some powerful and detailed models to manage changing environmental conditions within the Everglades. The SFWMD has a hydrological model of the Everglades marsh with canal structures at a resolution of 2 meters. Furthermore, the USGS has finer scale models that incorporate ground water interactions, although they cover a smaller geographical area. Both agencies also use urban growth models, sea level rise and tidal models, and vegetative succession models, enabling predicted responses to different water management scenarios (Pearlstone and Mazzotti, 2003). What the Phosphorus Reduction Planning Tool lacks, however, is a meaningful temporal component in regards to the effect of precipitation. GPM will be able to provide that component.

4. Programmatic and Societal Benefits

The Everglades is a delicate ecosystem that is in serious peril because of environmental changes in and around the ecosystem. However, progress to improve these wetlands has been documented. For example, in July 2001 the SFWMD reported a 73 percent reduction from the previous year in phosphorus discharged from the EAA. This reduction, the largest since the Everglades Forever Act's passage, exceeded the legislatively required decrease by nearly three times (U.S. Sugar, 2003). However, much more progress is required to avert the danger now faced by the Everglades. A large number of programs are still being designed to protect and restore the Everglades. Understanding how effective these programs are in terms of phosphorus reduction is one of the goals of the Comprehensive Everglades Restoration Plan. GPM measurements could augment the in situ precipitation measurements, therefore strengthening the components of the CERP. This solution is strongly aligned to the Coastal Management, Water Management, and Ecological Forecasting National Applications.

5. References

- FDEP [Florida Department of Environmental Protection], 2007. *Everglades Forever: State and Federal Legislation*. <http://www.dep.state.fl.us/evergladesforever/restoration/legislation.htm> (accessed July 11, 2007).
- Hoeweler, R., 2004. *Sugar, Politics, and the Everglades*. University of Miami, Ohio, <http://jrscience.wcp.muohio.edu/fieldcourses04/PapersMarineEcologyArticles/SugarPoliticsandTheEvergl.html> (accessed July 11, 2007).
- Hornung, L., and F. Salmon, 2003. Decision support for restoring the Everglades: A Phosphorus Reduction Planning Tool. Abstract, *Proceedings: 23rd Annual ESRI International User Conference*, July 7–11, San Diego, CA, <http://gis2.esri.com/library/userconf/proc03/abstracts/a1065.pdf> (accessed July 9, 2007).
- NASA [National Aeronautics and Space Administration], 2006. *Earth Science Reference Handbook: A Guide to NASA's Earth Science Program and Earth Observing Satellite Missions*. NP-2006-??-???-GSFC (C.L. Parkinson, A. Ward, and M.D. King, eds.), Goddard Space Flight Center, Greenbelt, MD, http://eosps0.gsfc.nasa.gov/ftp_docs/2006ReferenceHandbook.pdf, pp. 205–209.
- NASA, 2007. *Global Precipitation Measurement*. Goddard Space Flight Center, <http://gpm.gsfc.nasa.gov/groundvalidation.html> (accessed July 10, 2007).
- Pearlstine, L., and F. Mazzotti, 2003. *A Spatially-Explicit Decision Support System for Everglades Risk Assessment and Restoration*. Annual Report: December 2003, prepared for U.S. Geological Survey, Miami. <http://plaza.ufl.edu/pearlstn/DSSreview.pdf> (accessed July 2, 2007).
- Tourtellot, J.B., 2007. Destinations scorecard: National Parks. *National Geographic Traveler* July/August: 80–90, <http://www.nationalgeographic.com/traveler/pdf/NPDestinationScorecardJA05.pdf> (accessed July 16, 2007).
- U.S. Sugar [United States Sugar Corporation], 2003. *The Everglades Forever Act*. http://www.ussugar.com/environment/everglades_forever_act.html (accessed July 17, 2007).